

IN THE CLAIMS:

Withdraw claims: 1-123, without prejudice.

Rewrite the pending claims and add new claims as follows:

112
1-123. (Withdrawn)

113
124. (New) A multi-mode PAM output driver for driving a symbol, the output driver comprising:
logic circuitry; and
a driver circuit coupled to the logic circuitry and configured to drive the symbol;
wherein the multi-mode PAM output driver is capable of operating in a specified mode of a plurality of predefined modes;
wherein the symbol is an N-PAM symbol when the specified mode is a first mode;
wherein the symbol is an M-PAM symbol when the specified mode is a second mode;
and
wherein N is not equal to M.

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125. (New) The multi-mode PAM output driver of claim 124, wherein N is equal to 2.

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126. (New) The multi-mode PAM output driver of claim 124, wherein N is equal to 2 and M is equal to 4.

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127. (New) The multi-mode PAM output driver of claim 124, wherein M and N are both integers selected from the group consisting of 2, 4, 8, and 16.

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128. (New) The multi-mode PAM output driver of claim 124, wherein the output driver drives the symbol onto a multi-drop bus.

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129. (New) The multi-mode PAM output driver of claim 124,
wherein the logic circuitry is configured to receive data;
wherein, when the specified mode is a first mode, the driver circuit outputs signals representing the received data, the signals including one or more N-PAM modulated symbols; and
wherein, when the specified mode is a second mode, the driver circuit outputs signals representing the received data, the signals including one or more M-PAM modulated symbols.

119 130. (New) The multi-mode PAM output driver of claim 129, wherein, when the specified mode is a second mode, the received data comprises at least two bits including a most significant bit (MSB) and a least significant bit (LSB).

120 131. (New) The multi-mode PAM output driver of claim 129, wherein the received data represents at least part of an address in a memory system.

121 132. (New) The multi-mode PAM output driver of claim 129, wherein the received data represents at least part of a value stored in a memory system.

122 133. (New) The multi-mode PAM output driver of claim 129, wherein the received data represents at least part of a command in a memory system.

123 134. (New) The multi-mode PAM output driver of claim 124, wherein, when the specified mode is a first mode, the driver circuit drives a sequence of symbols representing received data at a first symbol rate, the sequence of symbols including one or more N-PAM modulated symbols; wherein, when the specified mode is a second mode, the driver circuit drives a sequence of symbols representing the received data at a second symbol rate, the sequence of symbols including one or more M-PAM modulated symbols; and wherein the first symbol rate is not equal to the second symbol rate.

124 135. (New) The multi-mode PAM output driver of claim 134, wherein the first symbol rate is twice the second symbol rate.

125 136. (New) The multi-mode PAM output driver of claim 134, wherein the ratio between the second symbol rate and the first symbol rate is equal to $\log_2(N)/\log_2(M)$.

126 137. (New) A multi-mode PAM receiver for receiving a symbol, the receiver comprising: a receiver circuit configured to receive the symbol; and logic circuitry coupled to the receiver circuit; wherein the multi-mode PAM receiver is capable of operating in a specified mode of a plurality of predefined modes; wherein the received symbol is an N-PAM symbol when the specified mode is a first mode;

wherein the received symbol is an M-PAM symbol when the specified mode is a second mode; and

wherein N is not equal to M.

- 127 138. (New) The multi-mode PAM receiver of claim 137, wherein N is equal to 2.
- 128 139. (New) The multi-mode PAM receiver of claim 137, wherein N is equal to 2 and M is equal to 4.
- 129 140. (New) The multi-mode PAM receiver of claim 137, wherein M and N are both integers selected from the group consisting of 2, 4, 8, and 16.
- 130 141. (New) The multi-mode PAM receiver of claim 137, wherein the receiver circuit outputs one or more binary signals.
- 131 142. (New) The multi-mode PAM receiver of claim 141, where the receiver circuit outputs the one or more binary signals synchronized to a clock signal.
- 132 143. (New) The multi-mode PAM receiver of claim 137, wherein the receiver circuit latches the symbol at a symbol rate selected from a plurality of predefined symbol rates.
- 133 144. (New) The multi-mode PAM receiver of claim 137, wherein, when the specified mode is a second mode, the received symbol represents two or more bits including a most significant bit (MSB) and a least significant bit (LSB).
- 134 145. (New) The multi-mode PAM receiver of claim 137, wherein the received symbol represents at least a part of an address in a memory system.
- 135 146. (New) The multi-mode PAM receiver of claim 137, wherein the received symbol represents at least a part of a value stored in a memory system.
- 136 147. (New) The multi-mode PAM receiver of claim 137, wherein the received symbol represents at least a part of a command in a memory system.
- 137 148. (New) The multi-mode PAM receiver of claim 137, wherein, when the specified mode is a first mode, the receiver circuit receives a sequence of symbols at a first symbol rate, the sequence of symbols including one or more N-PAM modulated symbols;

wherein, when the specified mode is a second mode, the receiver circuit receives a sequence of symbols at a second symbol rate, the sequence of symbols including one or more M-PAM modulated symbols; and

wherein the first symbol rate is not equal to the second symbol rate.

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150 149. (New) The multi-mode PAM receiver of claim 148, wherein the first symbol rate is twice the second symbol rate.

139 150. (New) The multi-mode PAM receiver of claim 148, wherein the ratio between the second symbol rate and the first symbol rate is equal to $\log_2(N)/\log_2(M)$.

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140 151. (New) The multi-mode PAM receiver of claim 137,
wherein the receiver circuit comprises a first receiver circuit and a second receiver circuit, each of the first and the second receiver circuits configured to output one or more signals;
wherein the signals output by the first receiver circuit represent a most significant bit (MSB) of the symbol; and
wherein, when the specified mode is a second mode, the signals output by the second receiver circuit represent a least significant bit (LSB) of the symbol.

141 152. (New) The multi-mode PAM receiver of claim 151,
wherein the first receiver circuit includes a MSB latching comparator to compare the symbol to a first reference voltage to generate a first signal representing a state of the MSB;
wherein the second receiver circuit includes a first LSB latching comparator to compare the input symbol to a second reference voltage and to generate a second signal representing a relationship between the symbol and the second reference voltage;
wherein the second receiver circuit includes a second LSB latching comparator to compare the input symbol to a third reference voltage and to generate a third signal representing a relationship between the symbol and the third reference voltage; and
wherein the second receiver circuit includes logic circuitry configured to generate a fourth signal representing a state of the LSB based, at least in part, on the second signal and the third signal.

142 153. (New) A multi-mode PAM transceiver comprising:
a multi-mode PAM output driver, configured to output a first stream of signals at a symbol rate on a first signal path; and

a multi-mode PAM receiver, configured to receive a second stream of signals at the symbol rate from a second signal path;

wherein the first stream of signals includes an N-PAM modulated symbol when a mode signal is in a first mode signal state;

wherein the first stream of signals includes an M-PAM modulated symbol when the mode signal is in a second mode signal state; and

where N is not equal to M.

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154. (New) The multi-mode PAM transceiver of claim 153, wherein the multi-mode PAM output driver and multi-mode PAM receiver are embodied on a single integrated circuit.

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155. (New) The multi-mode PAM transceiver of claim 153, wherein the first signal path and second signal path comprise the same physical medium.

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156. (New) The multi-mode PAM transceiver of claim 155, wherein the signal path is a multi-drop bus.

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157. (New) The multi-mode PAM transceiver of claim 153, wherein the first stream of signals includes at least one symbol representing at least a part of an address in a memory system.

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158. (New) The multi-mode PAM transceiver of claim 153, wherein the first stream of signals includes at least one symbol representing at least a part of a value stored in a memory system.

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159. (New) The multi-mode PAM transceiver of claim 153, wherein the first stream of signals includes at least one symbol representing at least a part of a command in a memory system.

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160. (New) The multi-mode PAM transceiver of claim 153, wherein N is equal to two.

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161. (New) The multi-mode PAM transceiver of claim 153, wherein N is equal to two and M is equal to four.

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162. (New) The multi-mode PAM transceiver of claim 153, wherein M and N are both integers selected from the group consisting of 2, 4, 8, and 16.

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163. (New) The multi-mode PAM transceiver of claim 153, wherein the state of the mode signal is determined by a hardware setting.

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164. (New) The multi-mode PAM transceiver of claim 153, wherein the symbol rate is determined by control logic, and the control logic determines the state of the mode signal based, at least in part, on the second stream of signals.

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165. (New) The multi-mode PAM transceiver of claim 153, wherein the symbol rate is selected from amongst a plurality of distinct symbol rates.

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166. (New) The multi-mode PAM transceiver of claim 153, wherein the symbol rate is determined by selecting the symbol rate from amongst a plurality of symbol rates, the plurality of symbol rates including a first symbol rate and a second symbol rate, wherein the second symbol rate is twice the first symbol rate.

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167. (New) The multi-mode PAM transceiver of claim 153, wherein the symbol rate is determined by selecting the symbol rate from amongst a plurality of symbol rates, the plurality of symbol rates including a first symbol rate and a second symbol rate, wherein the ratio between the second symbol rate and the first symbol rate is equal to $\log_2(N)/\log_2(M)$.

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168. (New) The multi-mode PAM transceiver of claim 153,
wherein, when a mode signal is in a first mode signal state, the first stream of signals output by the output driver is output at a first symbol rate, the first stream of signals including one or more N-PAM modulated symbols;

wherein, when a mode signal is in a second mode signal state, the second stream of signals output by the output driver is output at a second symbol rate, the second stream of signals including one or more M-PAM modulated symbols; and

wherein the first symbol rate is not equal to the second symbol rate.

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169. (New) The multi-mode PAM transceiver of claim 168, wherein the first symbol rate is twice the second symbol rate.

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170. (New) The multi-mode PAM transceiver of claim 168, wherein the ratio between the second symbol rate and the first symbol rate is equal to $\log_2(N)/\log_2(M)$.

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171. (New) The multi-mode PAM transceiver of claim 153,

wherein the first stream of signals has an associated first data rate when a mode signal is in a first mode signal state;

wherein the second stream of signals has an associated second data rate when the mode signal is in a second mode signal state; and

wherein the symbol rate is selected so as to make the first data rate equal to the second data rate.

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(New) A method of data transmission, comprising:

configuring an multi-mode PAM output driver to operate in a specified mode of a plurality of predefined modes;

receiving data at the multi-mode PAM output driver;

using the multi-mode PAM output driver, outputting a symbol corresponding to at least a portion of the received data;

wherein the symbol is an N-PAM symbol when a specified mode is a first mode;

wherein the symbol is an M-PAM symbol when the specified mode is a second mode;

and

wherein N is not equal to M.

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(New) The method of claim 172, wherein M and N are both integers selected from the group consisting of 2, 4, 8, and 16.

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(New) The method of claim 172, the method further including:

operating the multi-mode PAM output driver so as to drive a sequence of symbols onto a first signal path at a predetermined symbol rate, the sequence comprising a plurality of symbols, each symbol having a respective level of a predetermined number of PAM levels;

receiving, at a multi-mode PAM receiver, the sequence of symbols from a second signal path;

determining, based on a relationship between the sequence of driven symbols and the sequence of received symbols, an error metric; and

when the error metric is greater than an error metric threshold,

decreasing the symbol rate, the number of PAM levels, or both, and

subsequently repeating the operating the multi-mode PAM output driver, receiving at the multi-mode PAM receiver, and determining the error metric.

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175. (New) The method of claim 174, wherein the multi-mode PAM output driver and multi-mode PAM receiver are embodied on a single integrated circuit.

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176. (New) The method of claim 174, wherein the first signal path and second signal path comprise the same physical medium.

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177. (New) The method of claim 176, wherein the signal path is a multi-drop bus.

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178. (New) The method of claim 174, wherein the operating the multi-mode PAM output driver, receiving at the multi-mode PAM receiver, and determining the error metric are performed periodically at a rate defined by a predetermined interval of time.

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179. (New) The method of claim 174, wherein the symbol rate is initially one of a plurality of available symbol rates and the number of PAM levels is initially one of a plurality of available numbers of PAM levels, the method further comprising:

when the error metric is less than or equal to the error metric threshold and either the symbol rate is not the maximum symbol rate in the plurality of symbol rates, or

the number of PAM levels is not the maximum number of PAM levels in the plurality of numbers of PAM levels,

increasing the symbol rate, the number of PAM levels, or both, and subsequently repeating the operating the multi-mode PAM output driver, receiving at the multi-mode PAM receiver, and determining the error metric.

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180. (New) The method of claim 179, wherein the symbol rate is determined by selecting the symbol rate from amongst the plurality of available symbol rates, the plurality of available rates including a first symbol rate and a second symbol rate, wherein the second symbol rate is twice the first symbol rate.

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181. (New) The method of claim 179, wherein the symbol rate is determined by selecting the symbol rate from amongst the plurality of available symbol rates, the plurality of available rates including a first symbol rate and a second symbol rate, wherein the ratio between the second symbol rate and the first symbol rate is equal to $\log_2(N)/\log_2(M)$.

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182. (New) The method of claim 172, the method further including;

operating the multi-mode PAM output driver so as to drive a first sequence of symbols at a first symbol rate selected from a plurality of predetermined symbol rates, the sequence comprising a plurality of symbols, each symbol having a respective level of a first number of PAM levels, the first number of PAM levels selected from a plurality of available PAM levels;

receiving at a multi-mode PAM receiver the first sequence of symbols;

determining, based on voltage and timing characteristics of the first sequence of received symbols, a first set of signal characteristics, the set of signal characteristics corresponding to the first symbol rate and to the first number of PAM levels;

operating the multi-mode PAM driver so as to drive a second sequence of symbols at a second symbol rate selected from the plurality of predetermined symbol rates, the sequence comprising a plurality of symbols, each symbol having a respective level of a second number of PAM levels, the second number of PAM levels selected from the plurality of available PAM levels;

receiving at a multi-mode PAM receiver the second sequence of symbols;

determining, based on voltage and timing characteristics of the second sequence of received symbols, a second set of signal characteristics, the set corresponding to the second symbol rate and to the second level of predetermined number of PAM levels;

based on the first and the second set of characteristics, choosing a mode of operation of the system, the mode of operation specified, at least, by a symbol rate and a number of PAM levels.